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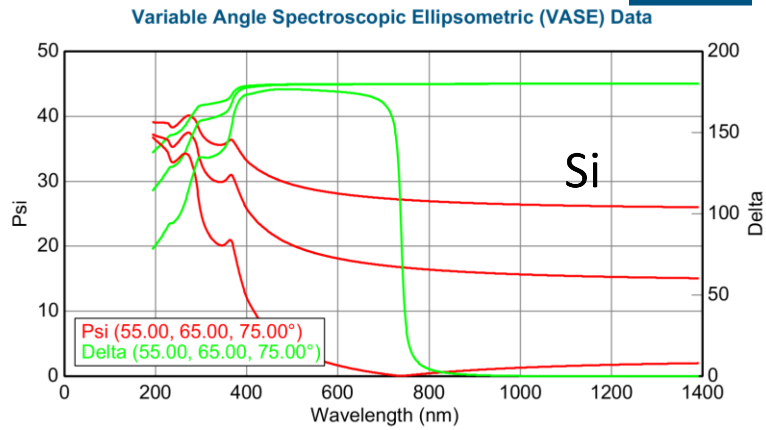
Data Interpretation

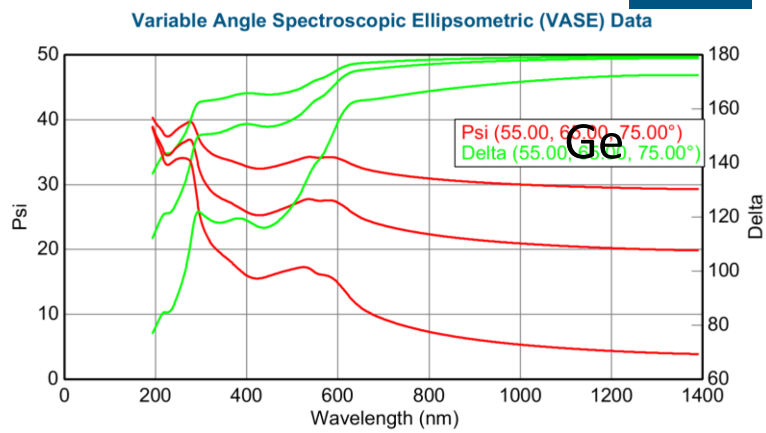
This note contains information related to identifying sample type from signature features in the raw ellipsometric data. Learning to identify sample type from data features allows users to choose an appropriate modeling strategy.

Ellipsometer types	M-2000, RC2, alpha-SE
Software	CompleteEASE
Typical data required	any
Typical model required	none
Considerations	Any known information about the sample (materials used, expected thicknesses)

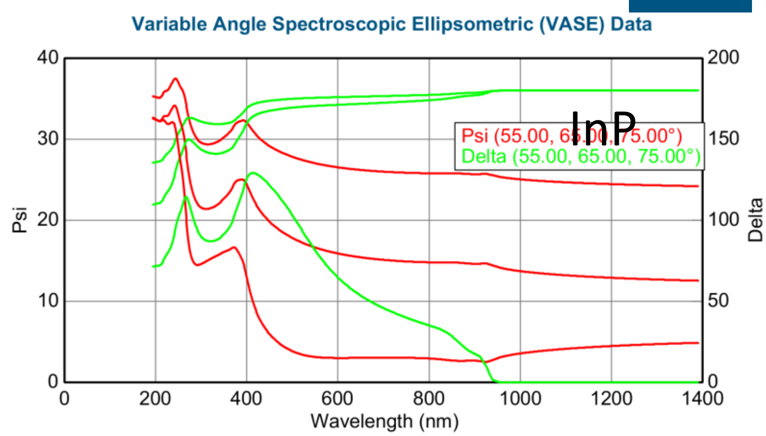
Semiconductor Substrates

For uncoated semiconductor substrates, psi will be smooth and flat at long wavelengths where material is transparent with increasing psi value and structure towards UV where material is absorbing. Expect sharp features near critical points in the optical properties.





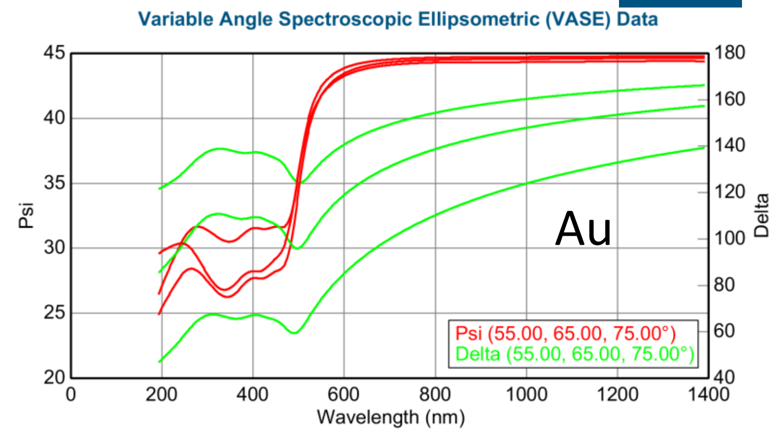
Semiconductor substrates are usually easiest to model as optical properties are well established and consistent from sample to sample. Published or library optical properties are usually a good representation of the material. Consider if the substrate has a native oxide or if backside reflections are present in the data.



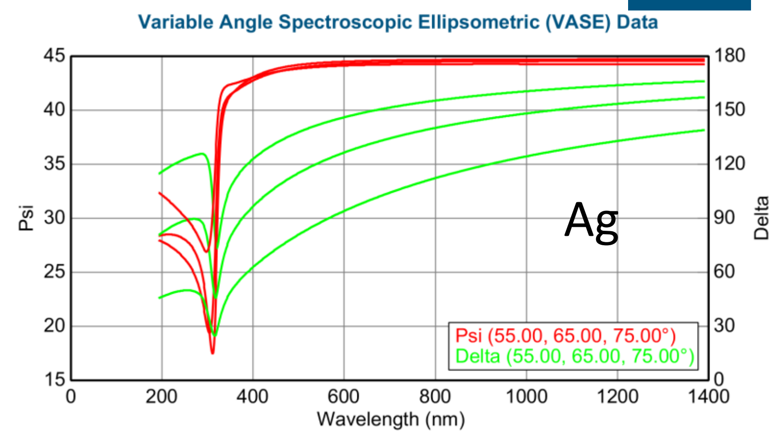
Data from uncoated semiconductor substrates can be modeled using procedure detailed in “Silicon Substrates” note.

Metal Substrates

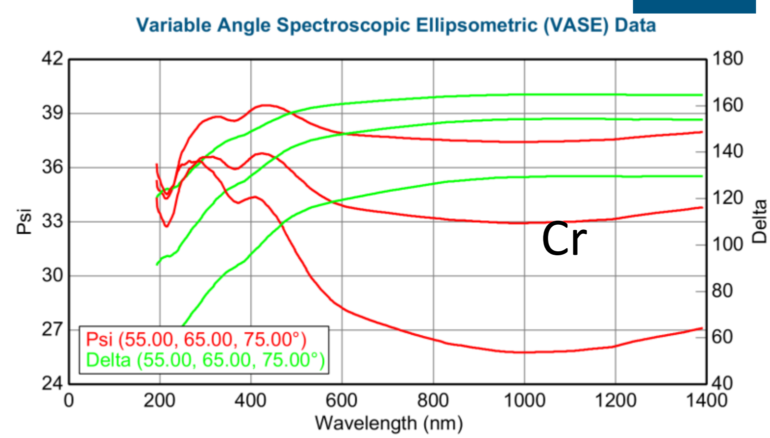
Metal substrates may be bulk material or sufficiently thick metal film over other substrate. Metal films greater than ~35-50nm will block any underlying material and effectively act as optical substrate.



Delta will typically increase towards IR. Psi may approach 45°.



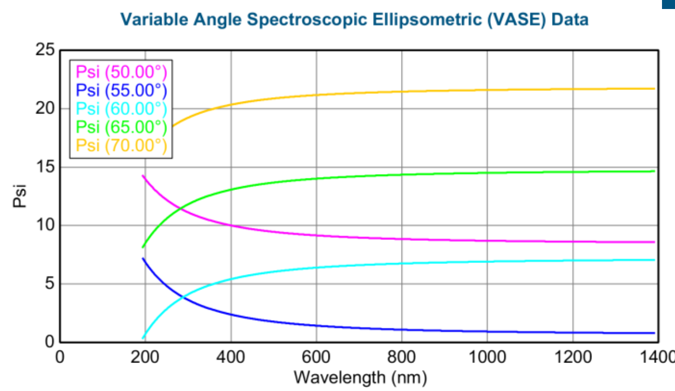
Metal optical properties are highly variable. Library values may serve as good starting values, but exact properties should be determined from your own uncoated metal sample whenever possible. B-Spline is usually preferred.



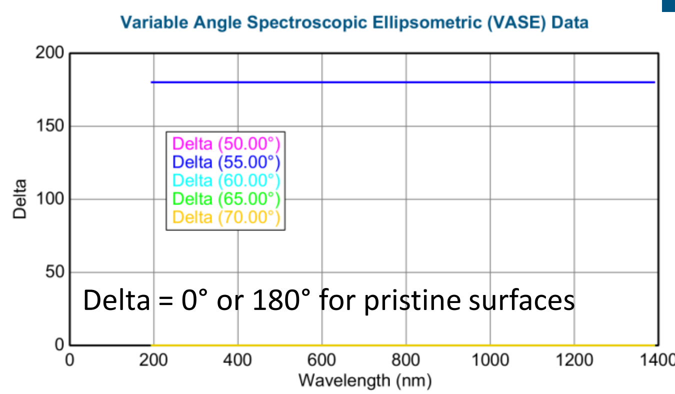
Data from uncoated metal substrates can be modeled using procedure detailed in “Metal Substrates” note.

Transparent Substrates

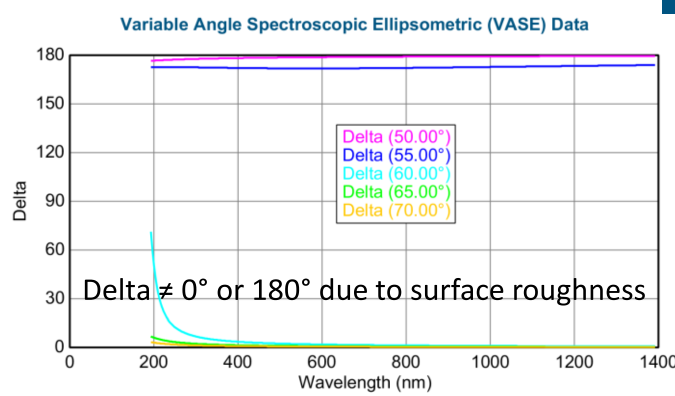
For uncoated transparent substrates, psi will be smooth and relatively flat. Delta will be 0° or 180° at all wavelengths if surface is pristine. Many substrates have roughness or other surface effects which cause Delta to shift slightly away from these values.



Cauchy equation is most commonly used dispersion model for transparent materials. Sellmeier is another option and may be preferred depending on material and spectral range.



Data from uncoated transparent substrates can be modeled using procedure detailed in "Transparent Substrates" note.



If your data has regions of transparency, you can limit the analysis range and use or start with the same procedures.

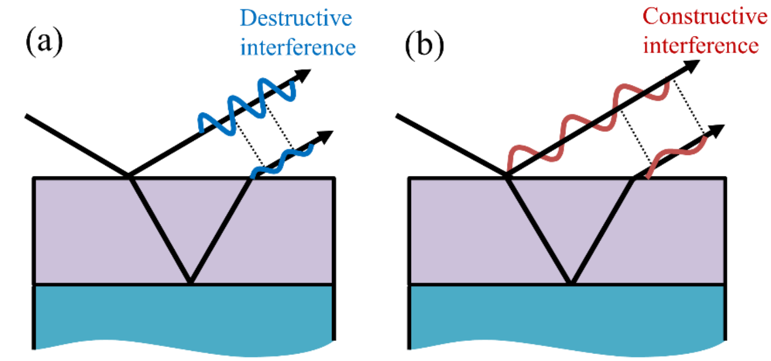
Transparent Films

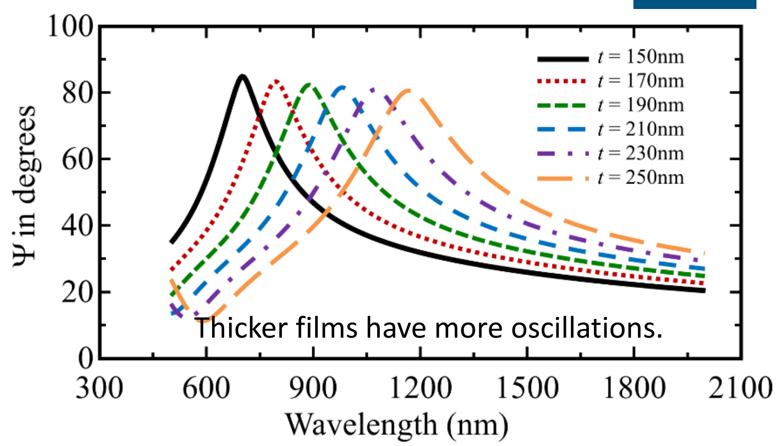
Interference causes oscillations in psi and delta for films greater than ~50-100nm thick. Thicker films have more oscillations. Amplitude of oscillations is related to optical contrast between film and substrate.

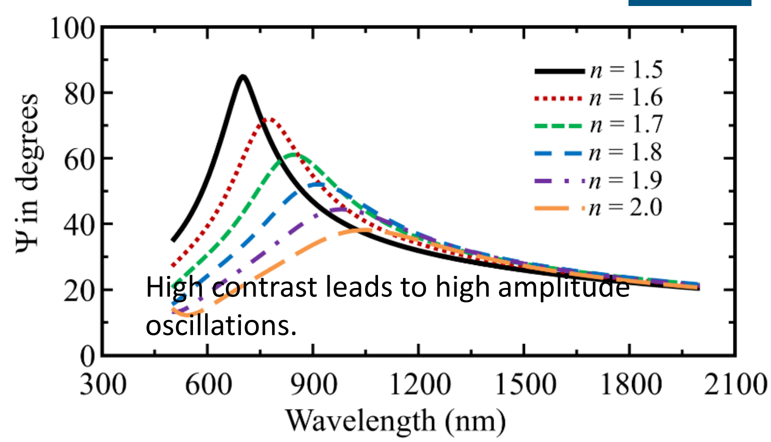
Data with these features can be modeled with procedure detailed in “Transparent Films” note.

If your data has regions of transparency, you can limit the analysis range and use or start with the same procedures.

Cauchy equation is most commonly used dispersion model for transparent materials. Sellmeier is another option and may be preferred depending on material and spectral range.





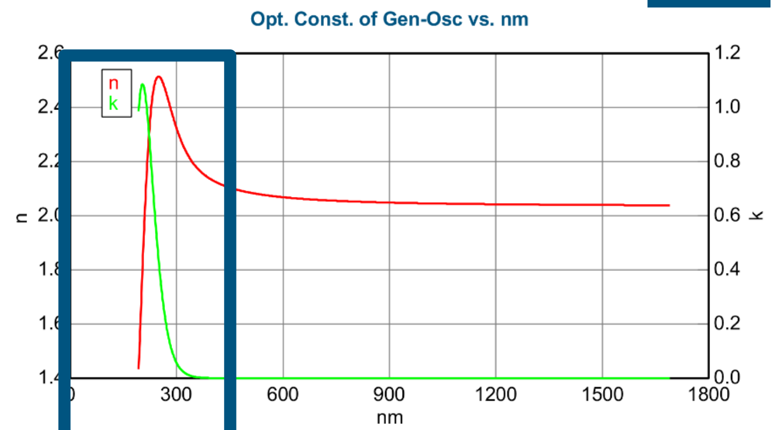


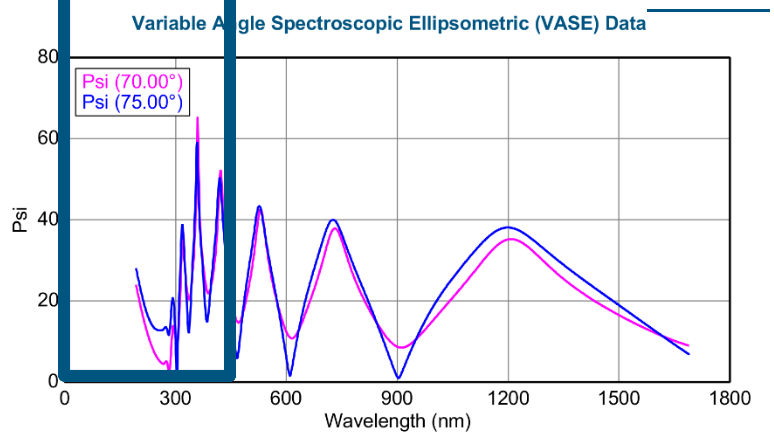
UV-Absorbing Films

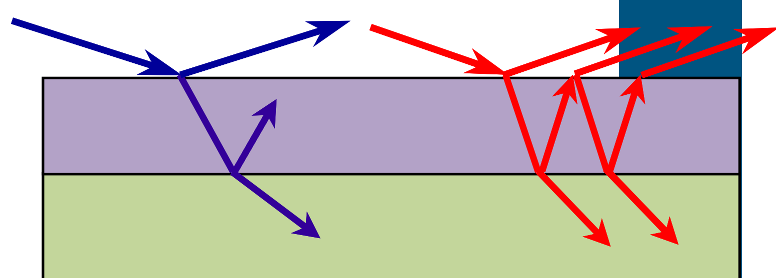
Many otherwise transparent films have absorption onset in the UV.

The absorption dampens and eventually eliminates oscillations occurring in the transparent region.

Data with these features can be modeled with one of the prebuilt oscillator files in the software library, or by following the procedure detailed in “UV-Absorbing Films” note.







Absorbing Films

Data fingerprint of films which absorb over most or all measured wavelengths will depend on thickness of the film and chosen substrate.

Metal films greater than ~35-50nm will block all underlying material and appear as a metal substrate.

Absorbing films over thick oxide will dampen oxide interference oscillations.

Other variations are shown right.

Not all substrate types will work for successful analysis of absorbing films.